Optimum Nitrogen Management Strategies

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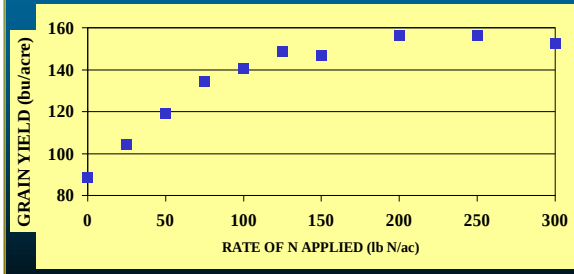
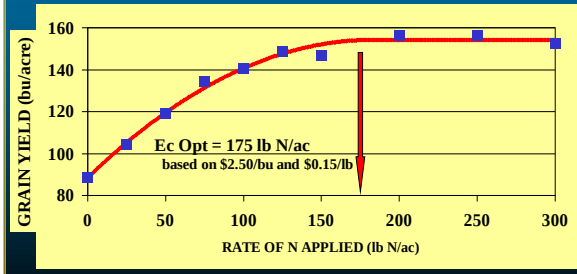
Nitrogen Recommendations

1) How much N should be applied?
2) Economic Optimum Rate (Ec Opt)
3) Point where the last increment in N applied is paid for by the increment of increased yield
4) < Ec Opt = not maximizing returns
5) > Ec Opt = waste of money
6) Economic Optimum ≠ Maximum yield
7) How is Economic Optimum determined?

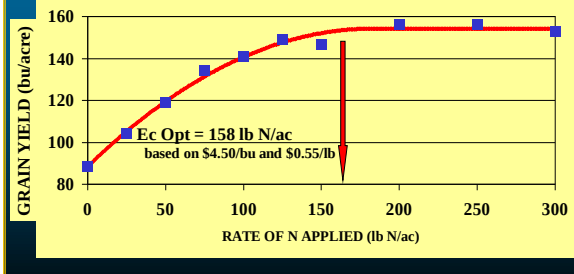
Economic Optimum N Rate



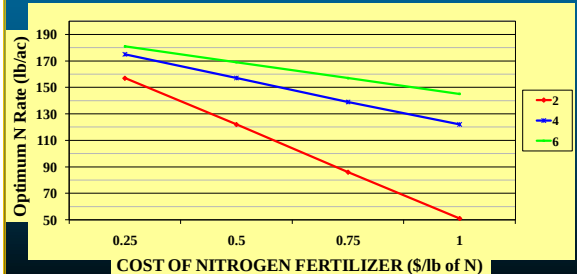
Economic Optimum N Rate

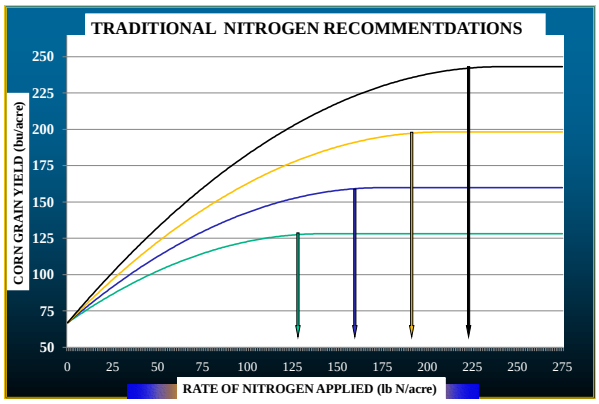


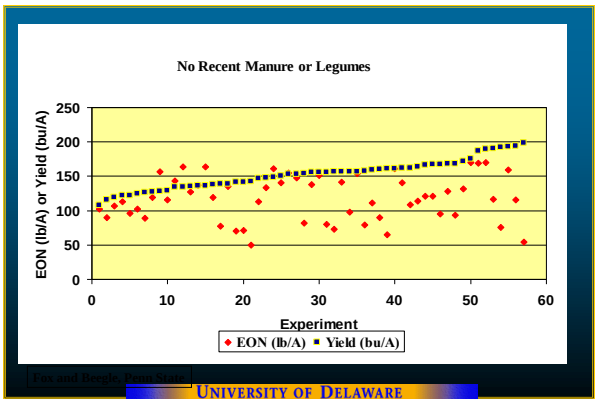
Economic Optimum N Rate



Economic Optimum N Rate




TRADITIONAL NITROGEN RECOMMENTDATIONS
CORN GRAIN YIELD (bu/acre)
250
225
200
175
150
125
100
75
50
0 25 50 75 100 125 150 175 200 225 250 275
RATE OF NITROGEN APPLIED (lb N/acre)


No Recent Manure or Legumes
EON (lb/A) or Yield (bu/A)
250
200
150
100
50
0
0 10 20 30 40 50 60
Experiment
EON (lb/A)
Yield (bu/A)
Fox and Beegle, Penn State
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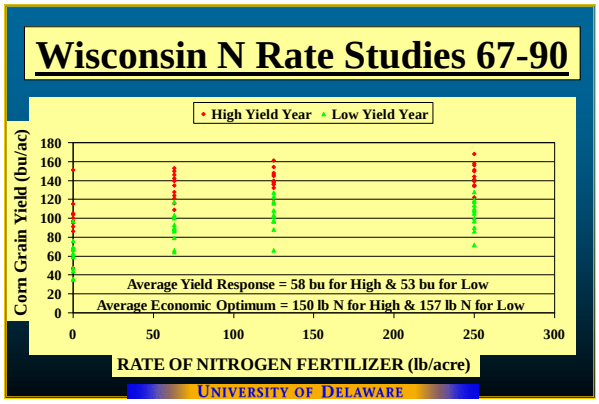
Wisconsin N Rate Studies 67-90
High Yield Year
Low Yield Year
Corn Grain Yield (bu/ac)
180
160
140
120
100
80
60
40
20
0
Average Yield Response = 58 bu for High & 53 bu for Low
Average Economic Optimum = 150 lb N for High & 157 lb N for Low
0 50 100 150 200 250 300
RATE OF NITROGEN FERTILIZER (lb/acre)
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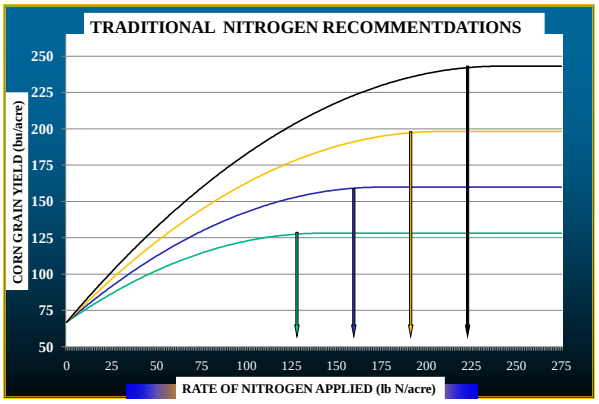
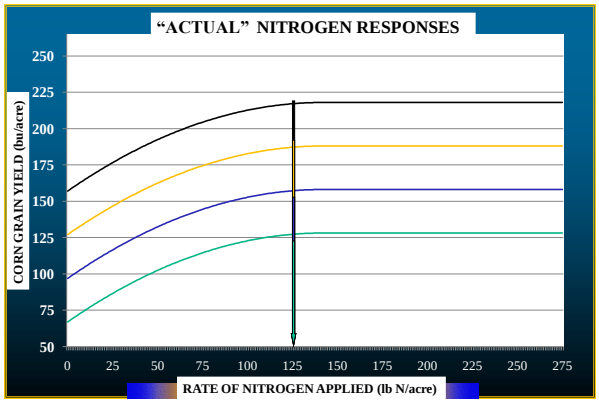
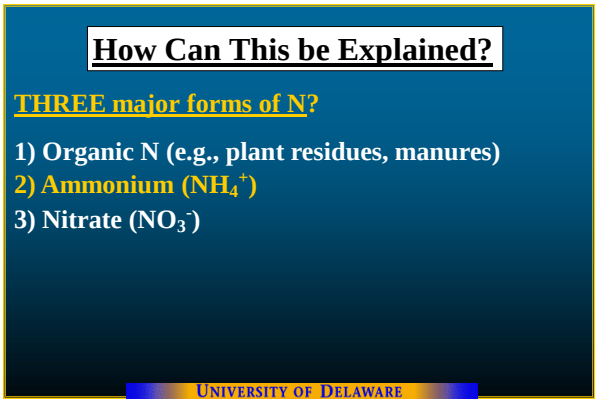

TRADITIONAL NITROGEN RECOMMENTDATIONS
CORN GRAIN YIELD (bu/acre)
250
225
200
175
150
125
100
75
50
0 25 50 75 100 125 150 175 200 225 250 275
RATE OF NITROGEN APPLIED (lb N/acre)


"ACTUAL" NITROGEN RESPONSES
CORN GRAIN YIELD (bu/acre)
250
225
200
175
150
125
100
75
50
0 25 50 75 100 125 150 175 200 225 250 275
RATE OF NITROGEN APPLIED (lb N/acre)


How Can This be Explained?
THREE major forms of N?
1) Organic N (e.g., plant residues, manures)
2) Ammonium (NH_4^+)
3) Nitrate (NO_3^-)
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Organic Nitrogen

1) Plant residues, manures, soil OM
2) Plants CANNOT use until mineralizes
3) Mineralization: Biological Process
   Organic N => Ammonium (NH_4^+)
4) Soil Organic Matter: 3% = 3,000 lb N/ac
5) SOM can supply 20 to 100 lb N/ac per year

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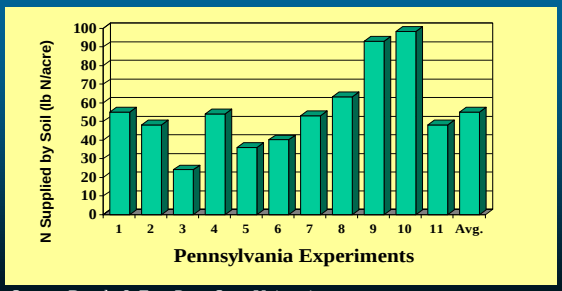
N Supplying Capacity of PA Soils



Source: Beegle & Fox, Penn State University

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What Should We Do?

1) Most Data Suggests Need ~150 to 175 lb N/ac
2) Take Credit for "Other N Sources"
3) Other N Sources: Animal Manure, Legumes, Crop Rotation, N in Irrigation Water
4) Maximize NUE (Nitrogen Use Efficiency)
5) NUE is maximized through TIMING, PLACEMENT, and Nitrogen ENHANCERS
6) Use Diagnostic Tools: PSNT, LCM, CSNT, RS

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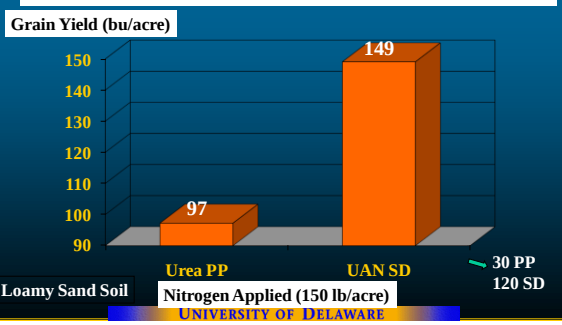
Time of Application (2005)



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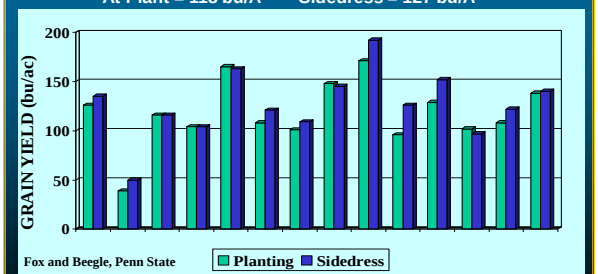
Time of N Application

At-Plant = 118 bu/A Sidedress = 127 bu/A



Avoid Leaching & Denitrification with Sidedressing

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Manure as an N Source

1) Fertilizer costs have greatly increased value
2) Still difficult to know manure credit
3) Book values are good starting point for estimating N credits…BUT…to maximize value...
4) Manure credits should be fine-tuned on a site-specific basis using diagnostic tools
5) These tools include: PSNT, LCM, CSNT, RS
6) Increased value = greater incentive to haul

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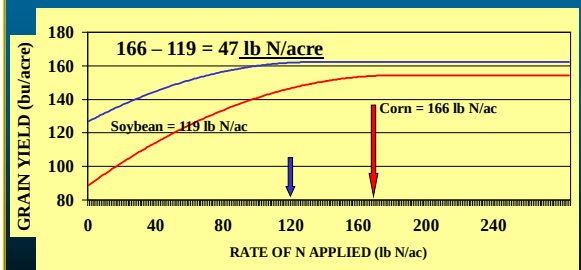
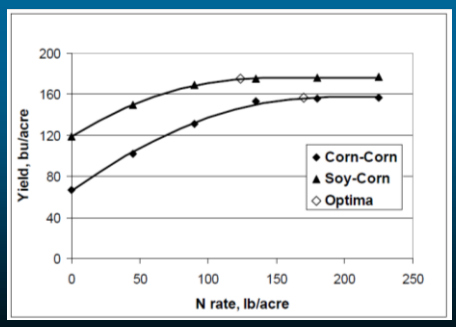
Rotating with Soybeans, etc.





NITROGEN TECHNOLOGY

1) Products designed to improve NUE
2) Nitrification Inhibitors
3) Urease Inhibitors
4) Slow Release Products

NITROGEN TECHNOLOGIES

1) Agrotain = urease inhibitor
2) Agrotain Plus = urease + nitrification inhibitor
3) Super U = urease + nitrification inhibitor
4) Nutrisphere-N = urease + nitrification inhibitor?
5) ESN = polymer-coated urea fertilizer
6) N Serve = nitrification inhibitor

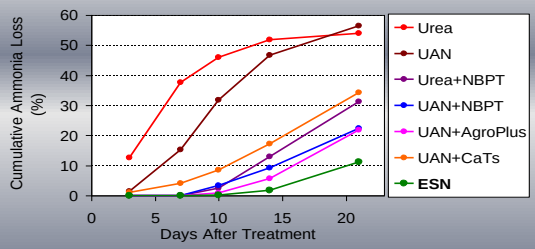
Urease Inhibitors

1) Urease is the enzyme that breaks down urea
2) Urea ($NH_2 – CO – NH_2$) => NH_4 Carbonate
3) NH_4^+ in a high pH environment goes to $NH_3(g)$

$NH_4^+ <=> NH_3(g) + H^+$

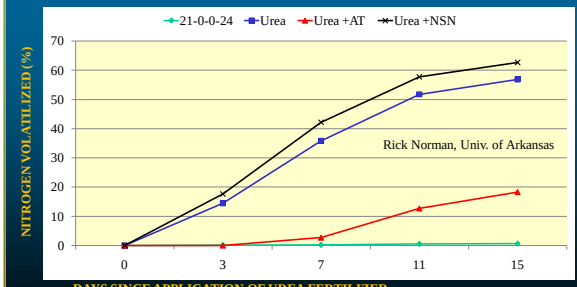
4) Urease inhibitors keep N as urea until in soil
5) If urea gets into the soil (rain or tillage), then there is no need for a urease inhibitor

ESN/Agrotain Ammonia Losses



Source: Dr. W. Thornberry, Sturgis, KY; Dr. S. Ebelhar, Univ of Illinois
Laboratory incubation

Ammonia Volatilization: AT/NSN



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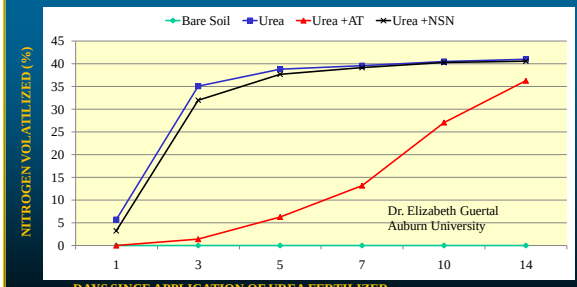
Ammonia Volatilization: AT/NSN



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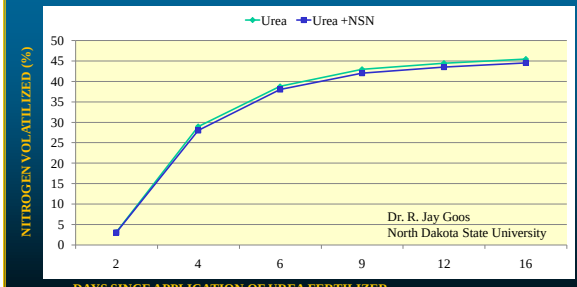
Ammonia Volatilization: NSN



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NITRIFICATION INHIBITOR

1) Conversion of Ammonium to Nitrate
2) $NH_4^+ + 2O_2 \Rightarrow NO_3^- + H_2O + 2H^+$
3) Biological Process
4) Nitrification is temperature dependent
5) Nitrification inhibitor SLOWS the conversion of ammonium (NH_4^+)to nitrate (NO_3^-)
6) Nitrate is susceptible to leaching losses!
7) Form of fertilizer: does nothing for NITRATE

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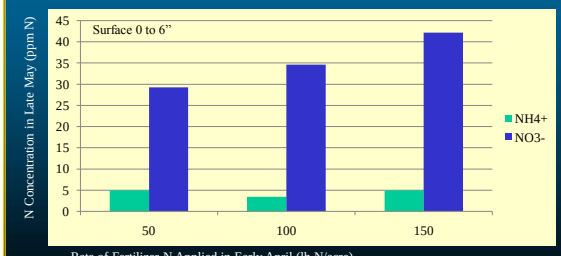
Nitrification of Ammonium Sulfate



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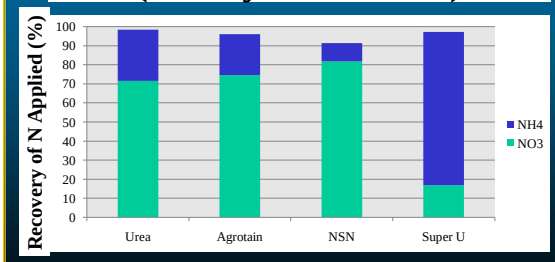
Effect on Nitrification (14-day incubation)



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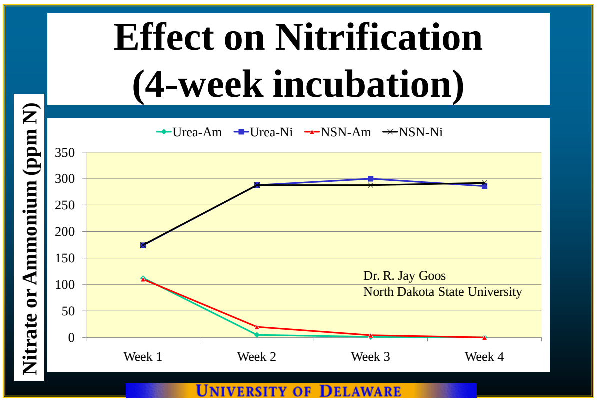
Effect on Nitrification
(4-week incubation)
Nitrate or Ammonium (ppm N)
Urea-Am
Urea-Ni
NSN-Am
NSN-Ni
350
300
250
200
150
100
50
0
Dr. R. Jay Goos
North Dakota State University
Week 1
Week 2
Week 3
Week 4
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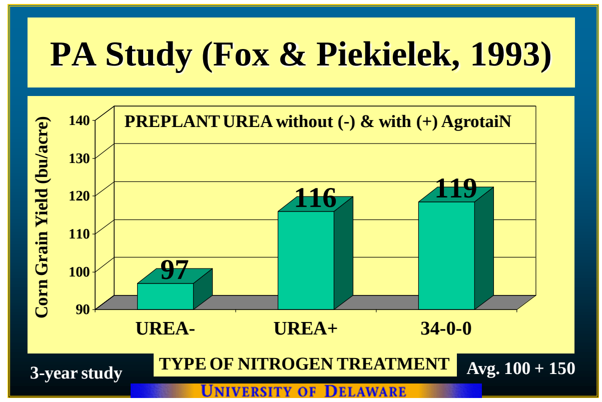
PA Study (Fox & Piekielek, 1993)
PREPLANT UREA without (-) & with (+) AgrotaiN
Corn Grain Yield (bu/acre)
140
130
120
110
100
90
97
116
119
UREA-
UREA+
34-0-0
3-year study
TYPE OF NITROGEN TREATMENT
Avg. 100 + 150
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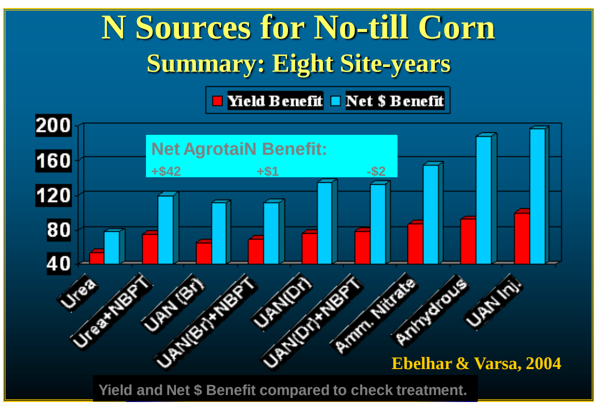
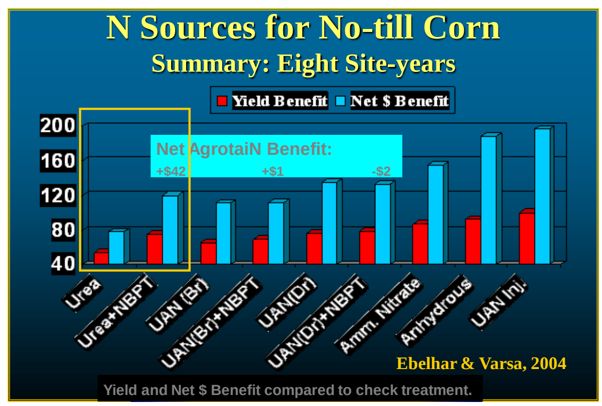

N Sources for No-till Corn
Summary: Eight Site-years
Yield Benefit
Net $ Benefit
200
160
120
80
40
Net AgrotaiN Benefit:
+$42
+$1
-$2
Urea
Urea+NBPT
UAN (Br)
UAN(Br)+NBPT
UAN(Dr)
UAN(Dr)+NBPT
Amm. Nitrate
Anhydrous
UAN Inj.
Ebelhar & Varsa, 2004
Yield and Net $ Benefit compared to check treatment.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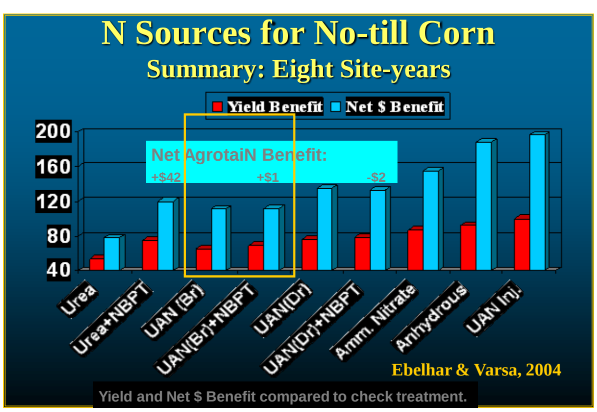
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120
80
40
Net AgrotaiN Benefit:
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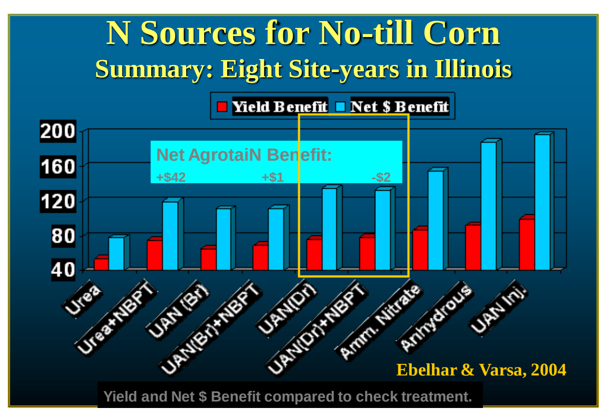
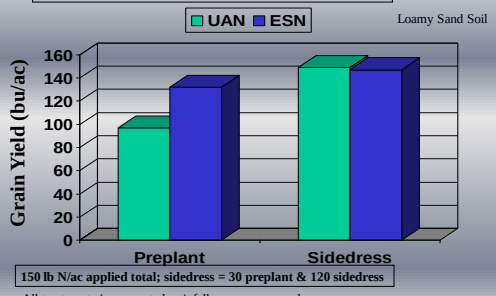
+$1
-$2
Urea
Urea+NBPT
UAN (Br)
UAN(Br)+NBPT
UAN(Dr)
UAN(Dr)+NBPT
Amm. Nitrate
Anhydrous
UAN Inj.
Ebelhar & Varsa, 2004
Yield and Net $ Benefit compared to check treatment.


N Sources for No-till Corn
Summary: Eight Site-years in Illinois
Yield Benefit
Net $ Benefit
200
160
120
80
40
Net AgrotaiN Benefit:
+$42
+$1
-$2
Urea
Urea+NBPT
UAN (Br)
UAN(Br)+NBPT
UAN(Dr)
UAN(Dr)+NBPT
Amm. Nitrate
Anhydrous
UAN Inj.
Ebelhar & Varsa, 2004
Yield and Net $ Benefit compared to check treatment.

Delaware: Irrigated Corn in 2005

Statistically significant yield differences except for SD treatments



150 lb N/ac applied total; sidedress = 30 preplant & 120 sidedress

All treatments incorporated; rainfall was near-normal

DIAGNOSTIC TOOLS

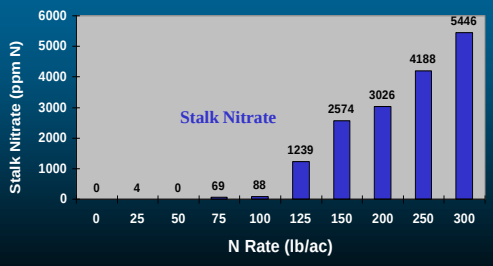
1) The value of these tools becomes greater and greater as the cost of N increases

2) PSNT = tool to quantify manure N release

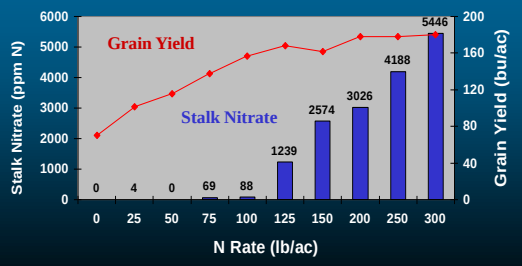
3) LCM = tool to determine N status

4) CSNT = tool to evaluate the N status during the entire growing season…how'd we do?

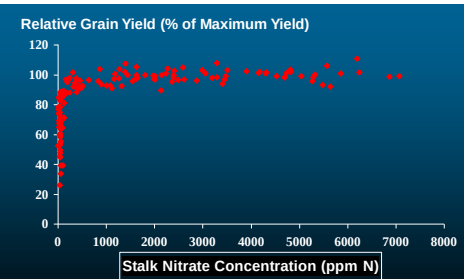
End-of-season stalk nitrate test



End-of-season stalk nitrate test

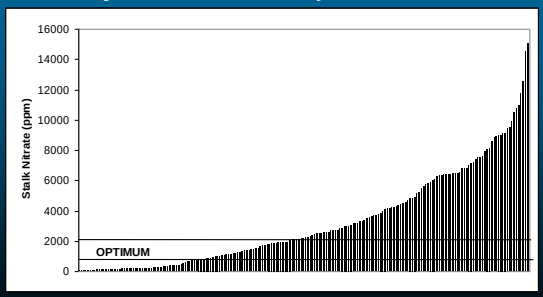


Yield vs. Stalk Nitrate



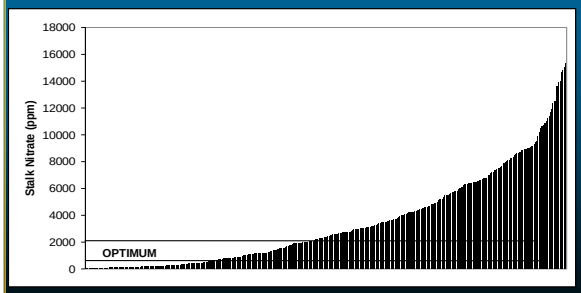
End of Season Stalk Nitrate Test Summary

262 Samples from PA Consultant Project from 2000 thru 2003



End of Season Stalk Nitrate Test Summary

417 Samples from Penn State Soil Test Lab in 2004



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SUMMARY

1) Optimal N rate is NOT equal to yield potential
2) Corn usually requires about 150 to 170 lb N/ac
3) New technologies have greater value when N is expensive and should be considered under correct situations (i.e., broadcasting urea)
4) Evaluate new products (i.e., like a new hybrid)
5) Site specific management using diagnostic tools has never been more important because of the costs required to apply fertilizer nitrogen!

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QUESTIONS???

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